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## Fire Resistance and Fire Reaction of Bio-Composite Sandwiches for Building Construction

Pietro Di Modica<sup>1(\*)</sup>, Angela Daniela La Rosa<sup>2</sup>, Gianluca Cicala<sup>2</sup>, George Kotsikos<sup>1</sup>, Geoff Gibson<sup>1</sup>

<sup>1</sup>Mechanical and System Engineering School, Newcastle University, Newcastle upon Tyne, UK

<sup>2</sup>Department of Industrial Engineering, University of Catania, Catania, Italy

(\*)Email: [p.di-modica@ncl.ac.uk](mailto:p.di-modica@ncl.ac.uk) or [pietrodimodica@hotmail.it](mailto:pietrodimodica@hotmail.it)

### ABSTRACT

Fire Resistance performance of Bio based sandwich panels were investigated. The tested samples consisted of bio-epoxy-flax fibre laminate composite skins with different cores: agglomerated cork sheets, balsa wood and PVC foam (La Rosa, 2014). 200X200 mm samples were fire tested at 35kW/m<sup>2</sup> to compare the results from reaction to fire measurements from cone calorimetry tests. Cork Sandwich performed better than PVC sandwich. A beneficial synergistic effect of the sandwich structure towards fire resistance was observed, increasing the fire resistance time by 40%.

### INTRODUCTION

Fire Reaction and Fire Resistance performance is what mostly limits composite applications in building construction. The use of composite materials in building construction is ruled by EN13501, EN1363 and EN1364. EN13501 establishes the type of tests and the necessary test requirements according to the final component application. The panels tested in this study were developed to be used as on load bearing walls. For this application EN13501 establishes that tests have to be performed according to EN1364-1 which recalls EN1363-1 describing the general requirements of the furnace to be used and the fire performances of the material. The furnace has to be capable of recreating a particular temperature-time curve, which using Stephan-Boltzman equation corresponds at an average constant heat flux of around 154 kW/m<sup>2</sup> over a 360 minutes exposure time (corresponding to a constant flame temperature of 1085°C) see Fig.1. Cone tests cannot be performed at such high heat flux so for comparison purpose fire tests were performed at 35kW/m<sup>2</sup> although this does not correspond to standard requirements. Fire tests were performed on 200X200X20 mm bio-composite sandwich samples (La Rosa, 2014; La Rosa 2014) with three different cores: agglomerated cork particles, balsa wood PVC foam. Cores and skins were separately fire tested as well. Flames were calibrated using the flames temperature according to Stephan-Boltzman. Flame temperature was measured by a type N thermocouple at 1cm far from sample surface, see Fig 1 b) and c). The cold face temperature was monitored with a type K thermocouple. The flame temperature corresponding to 35 kW/m<sup>2</sup> is 670 °C. The propane burner inlet pressure and sample distance were adjusted to obtain the above temperature (ISO 2685, 1998). Temperature transient profiles were recorded and the time it took to increase the initial temperature of 140K was then calculated.

### RESULTS AND CONCLUSIONS

Fire resistance times are shown in Table 1. It can be shown that all the sandwiches exceed 10 minutes (corresponding to 600 seconds) but just the cork and the PVC core sandwiches exceed 15 minutes fire resistance period. It can be noticed how the sandwich structure has synergistic effect in terms of fire resistance. If the fire resistance times of the single materials

would just be added, the result would be just around 500 seconds. However the minimum fire resistance time is almost 700, a 40% increase in fire resistance. Further cone calorimetry tests will be performed to better understand this phenomenon comparing results at the same heat flux.

Table 1 Time in seconds to reach 140K increase compared to initial temperature

Material	Sample 1	Sample 2	Sample 3	Average
<b>Skin</b>		237		
<b>Balsa core</b>		133		
<b>PVC core</b>	Flames passed through the sample before achieving the condition			
<b>TEK Cork core</b>	Flames passed through the sample before achieving the condition			
<b>EKO Cork core</b>	Flames passed through the sample before achieving the condition			
<b>Cork sandwich</b>	1061	925	1276	1087
<b>Balsa sandwich</b>	606	616	871	697
<b>PVC sandwich</b>	905	1046	894	948

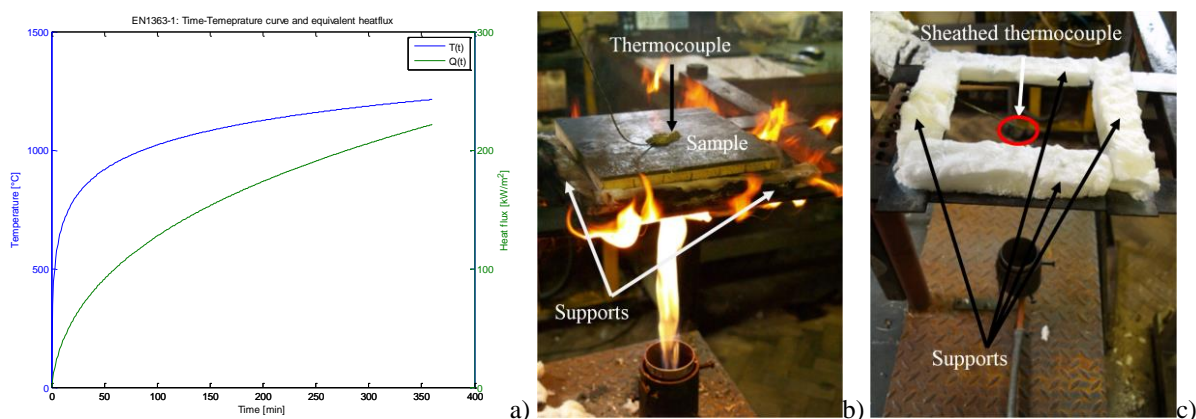


Fig.1: a) EN1363-1 Time-Temperature curve and Heat Flux; b) Test in progress; c) Test setup.

This study shows that there is a beneficial synergistic effect of the sandwich structure towards fire resistance. Further tests at higher heat flux are necessary to investigate possible building construction application according to EN13501. Further tests should be performed in order to analyze the morphology of the residue and better understanding of the fire protection mechanism.

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